NREL's Advanced HVAC Project: Research to Reduce Energy Use & Cost

The National Renewable Energy Laboratory (NREL) in Golden, Colo., tests and helps develop and deploy new energy-efficient technologies to benefit the environment and economy. NREL is managed for the U.S. Department of Energy (DOE) by Midwest Research Institute, Battelle Memorial Laboratory and Bechtel Corp.

The facility opened in 1974 as the Solar Energy Research Institute. In 1991, President George Bush designated NREL as a DOE national laboratory. Today, it is involved in nearly 50 areas of scientific investigation, including building energy use that covers cooling and dehumidification.

Cooling & Dehumidification

NREL's Center for Buildings & Thermal Systems develops technologies to help the nation reduce energy use by 30 to 70% in buildings, which account for more than 60% of national electricity consumption.

Researchers in the Center's Advanced HVAC (heating, ventilation and air-conditioning) Project are analyzing desiccant cooling systems and components and testing prototype systems. Desiccant systems remove moisture from the air, allowing cooling to be done much more efficiently. They have the potential to save about 400 trillion Btu of energy each year in U.S. buildings and could prevent the emission of more than 24 million tons of carbon dioxide.

Project researchers work with desiccant technologies in cost-shared partnership with members of the American Gas Cooling Center's Humidity Control Committee, which includes Gas Technology Institute (GTI), gas utilities and desiccant and HVAC equipment manufacturers. The partners are striving to:

- **benchmark current performance**
- **develop generic design tools**
- **develop and demonstrate new hardware**
- **support industry efforts to develop and implement rating and certification methods**
- **support technology transfer**
- **educate industry users.**

Steve Slayzak

These efforts – all aimed at bringing desiccant technology into mass markets – will reduce cost, improve performance and reliability, and broaden desiccant applications in commercial and residential buildings. Recently, Project scientists made major contributions to the creation of ARI/ASHRAE (Air-Conditioning & Refrigeration Institute / American Society of Heating, Refrigerating & Air-Conditioning Engineers) certification and testing standards for desiccant components, and began to participate in an effort to develop a residential desiccant-based dehumidifier. Project researchers are working with a Humidity Control Committee team to test prototype residential wheels and systems that meet criteria set by GTI market research. Team members include the University of Illinois-Chicago, Munters and Honeywell. Among niche markets, supermarkets and hotels have already saved considerable amounts of energy and operating costs with desiccant applications.

Thermal sciences experts on the Advanced HVAC Project are also joining DOE's CHP (cooling, heating and power) for Buildings Program. NREL manages DOE's roadmapping activities and sponsors component development research in this area. Integrated building CHP systems have the potential to achieve 70% overall natural resource utilization. Thermal recovery systems and cooling technologies, such as desiccants and absorption that are powered by heat, are critical to reaching this efficiency goal.

The Project operates what Steve Slayzak, senior project manager, Advanced HVAC Project, calls "a world-class test facility" that includes a ventilation test chamber and the Advanced HVAC Test Facility in which the effectiveness of air conditioning and distribution systems can be measured

DESICCANT COOLING BENEFITS

Desiccant cooling, used as stand-alone systems or to supplement conventional cooling equipment, removes moisture from the air without the use of ozone-depleting compounds. Desiccant materials (e.g., solid silica gel or synthetic polymer, or liquid lithium chloride) attract and collect moisture that is then removed with thermal energy from natural gas or some other source.

Desiccant cooling is ideal for many reasons. It improves air-conditioning system energy efficiency and thereby lowers fuel bills. The moisture control it provides enhances indoor air quality and occupant comfort in all types of buildings. In the long term, its application can improve U.S. economic competitiveness by reducing energy imports, increasing new technology exports, reducing pollution, and boosting international leadership in building technologies, according to DOE.

checks the seals on a prototype under evaluation at the NREL Advanced HVAC Test Facility.

with great accuracy. "Manufacturers are able to scrutinize their products in greater depth here," according to Slayzak. At present, the Project measures moisture removal in wheels with airflows up to 2,000 cubic feet per minute (cfm). The facility is being expanded to simultaneously test two wheels – one 6,000 cfm and one 4,000 cfm on a side – and to accommodate as many as 20 tests per day.

Contaminant Measurement & Removal

NREL is also investigating the ability of desiccant or sorbent systems to remove common contaminants from building air. These evaluations have not been attempted in the past because measuring air contaminants at typical indoor parts-per-billion air concentrations is a time-consuming and expensive proposition.

NREL researchers have developed techniques that halve the time required to evaluate a sorbent and are quantifying the effects of humidity on sorbent performance. Techniques developed for this work are laying the groundwork for the rapid performance evaluation of contaminant removal prototypes and development of field-deployable, real-time indoor air quality (IAQ) sensors.

Enthalpy Rotors

Low-cost, high-performance enthalpy or passive dehumidification wheels are "where we bring our technical expertise to bear and how we apply the unique capability that DOE has allowed us to develop," explains Slayzak. Enthalpy wheels perform like rotary heat exchangers, heating or cooling fresh air with the exhaust air stream, but they can also transfer moisture with the use of a desiccant. This reduces the total cooling/dehumidification load on the HVAC system.

NREL invites manufacturers to partner with it to advance technologies that have been identified for their value in reducing energy use. "In our low-cost rotor work, we're looking for new concepts, not incremental improvements," Slayzak points out.

Liquid Desiccant Equipment

Most installed desiccant systems use solid desiccant materials. NREL funds research on promising liquid desiccant technologies that have the potential to be 50% smaller and 40% less costly than solid desiccant systems. Researchers have already developed liquid desiccant components that can ensure that no desiccant leaves the system. This "zero carryover," coupled with two other recent improvements, internal cooling and advanced regeneration, will allow liquid systems to serve expanded markets at lower cost and greater energy savings. Slayzak notes, "Liquids are an area where we have had great success in improving desiccant systems through new concept research." ES

The National Renewable Energy Laboratory (NREL) mission is to lead the nation toward a sustainable energy future by developing renewable energy technologies, improving energy efficiency, advancing related science and engineering, and facilitating commercialization.

Further information is available from Steve Slayzak: 303-384-7527 **steven_slayzak@nrel.gov** or visit **www.nrel.gov/buildings_thermal/**